



# **C-5 Corrosion Program 2011**

**Air Force Corrosion Conference**



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# ***Presentation Overview***



- **Corrosion Program Team**
  - **Corrosion Control Website**
  - **Corrosion Program Concerns**
- **Non-Chrome Paint System Evaluations**
- **Coatings for Abrasion Protection**
- **Plastic Media Blasting for Paint Removal**
- **Material Changes to Resolve Corrosion and SCC Issues**
- **Aircraft Wash Procedure Development**
- **Av-Dec® Tape/Gasket Usage**
- **Lavatory Modification to Resolve Leaks**
- **Structural Grind-Out Limitations for Surface Corrosion**
- **Structural Bonding Process and Certification**
- **CPC Usage**
- **C-5M Refurbishment and Anti-Skid Removal Evaluation**



# ***C-5 Corrosion Program Team***



- **WR-ALC Program Manager - Clay Elliott**
  - Operating Base Maintenance Personnel
  - WR-ALC Equipment Specialist (Joel Mixon, Ron Walderman)
  - WR-ALC ASIP Manager (Dave Wilkinson)
  - Systems Branch Chief (Scott Wrigley)
  - WR-ALC Electrical/Avionics (Jan Ewing, Nick Pitman)
  - WR-ALC Depot Maintenance Personnel
  - Air Force Corrosion Prevention and Control Office  
(Mac McKenna, SMSgt Scott Pagenkopf, Owen Jett)
  - MSG-3 Team (Chris Carlton, Ed Reardon, Jackie Mason)
  - Lockheed Martin (Dan McTish)
  - Mandaree Enterprise Corporation (Mike Surratt, Larry Cornwell, Eric Lee, John Lindsey, Ed Reid, Talmadge Hutchins, Tom Helms, Josh Kingsley)



## ***C-5 Program Implementation Team***



- **Wing Corrosion Control Contacts**
  - Westover ARB (SMSgt Rob Ivey, SMSgt Mike Dirienzo, MSgt Joe Whalen)
  - Stewart ANGB (SMSgt Vince Lepore, Jeff Peak)
  - Lackland AFB (SMSgt Rodney Rael, MSgt Tom Bailey)
  - Martinsburg ANGB (MSgt Ed Schwartz, Chuck LaFaver)
  - Wright Patterson AFB (MSgt Joe Taylor)
  - Memphis ANGB (CMSgt Mark Wagner, Craig Tow)
  - Dover AFB (Dennis Walston, Greg Long, MSgt Reece Coleman)
  - Travis AFB (MSgt Logan Commings, MSgt Sheldon Jentzsch)
- **WR-ALC Maintenance Contacts**
  - Corrosion Control Supervisor (Hector Herrera)
  - Planning (Andy Ivey)
  - MRRB (Jim Rivers)



# Corrosion Control Website - AFIRM

<https://c5.robins.af.mil/afirm/asip/corrosion/corrosion.htm>

## C-5 Corrosion

Search for specific Status Report Topics and CPAB Presentations

Show all topics | Show Action Items Only

**AFIRM** **ASIP**

**Action Items**  
View Action Items  
Enter new Item  
June 2011 Updates / RMR

**Corrosion Log**  
G081 & Field Data  
Enter Data into Log

**CPCP Plan**

**CPC A/C Summary**

**Major Reports**  
Crew Deck Dent Limits

**Paint Scores**  
View Paint Scores  
Enter New Scores

**Training Videos**  
AC Wash Procedures

**Draft Technical Orders**  
Select T.O.

**Status Reports**  
Select Month

### C-5 Corrosion Prevention Advisory Board (CPAB) Conference

#### 2011 CPAB Presentations

Next Scheduled CPAB Conference: TBD

#### Overview

The goals of CPAB are identifying corrosion problems, formulating technical recommendations and establishing a basis for MAJCOM program funding and execution requirements. Experience shows that corrosion in aerospace systems can impact operational readiness, impact life cycle costs, and jeopardize system effectiveness. Corrosion is defined as the environmental deterioration of any material, metallic or nonmetallic, including the operating environmental degradation of all aircraft materials. AFI 21-105 outlines the responsibilities aimed at minimizing these threats throughout all phases of an aerospace system life cycle. The C-5 CPAB is structured in accordance with, and adheres to the intent of AFI 21-105.

#### Purpose

The purpose of the C-5 CPAB is providing all stake holders with a forum for identifying and discussing the impact of corrosion issues, indentifying and pursuing potential solutions, and providing the basis for MAJCOM funding and program execution requirements. The objective of the CPAB is controlling the effects and damage caused by corrosion to help maintain C-5 aircraft structural and funtional systems integrity. The CPAB also recommends direction to the corrosion prevention and control program to ensure effective corrosion considerations throughout the C-5 life cycle.

Previous CPAB Conferences:

Action  
Items

Corrosion Log

Corrosion Plan

CPC Usage

Paint Scores

Monthly  
Status  
Reports

Created by: Rich DiSalle, Lockheed Martin



# C-5 Corrosion Program Concerns



- **Current Base Level Concerns**

- New technicians expected to have working knowledge
  - Corrosion removal and repair methods
    - Use of AMS-1640 De-Oxidation prior to Alodine application
  - Grit-Blast/Sol-gel Bonding Certification per TO 1C-5A-3
- Qualified Products Lists (QPL's) need updated
- Materials not available with improved stress corrosion ratings (7249/7050/7085) to replace 7075-T6.

- **Engineering Concerns**

- Problem identification and resolution are quick to develop (3 months), but long to implement (+1 year)
  - Obtaining parts takes a long time (+1 year)
  - TCTO kits must be created to ensure sufficient stock is on hand



# ***Base Level Feedback***



- **Continue (or increase) engineering base level visits**
  - Keeps communication lines open
  - Updates engineers on base capabilities and limitations (always changing)
  - Emphasizes being proactive instead of reactive
  - Encourages base level participation in evaluating resolutions to CPAB action items
  - **Always Prototype/Kit-Proof CPAB corrective actions**
- **Too much time and money spent on studies and tests**
  - Need real time solutions with implementable corrective actions



# ***Non-Chrome Finish Systems***

## ***Beachfront/Laboratory Testing***



- Tests proceeding with qualified products.
    - Testing to be done with complete coating stack-up.
    - Outdoor exposure testing with Battelle and AFRL/CTIO at Daytona and Tyndall AFB.
      - PreKote/Aerodur 2100 (Mg-Rich)/Aerodur 5000 (AkzoNobel System)
      - PreKote/Aerodur 2100 (Mg-Rich)/99GY001
    - RECC1015/RECC3021/02GN093/99GY001 (Deft System)
    - Alodine 5200/53055GEP-17036CEH35515APX-35502CMU (Hentzen System)
- F-15**
- EAP-9/PRC CA7236 or CA7502/PRC CA9311 (PPG)
  - PreKote/Deft 02-Y-040/Deft 99-GY-001 (Control 1)
  - Alodine 1200/Deft 02-Y-040/Deft 99-GY-001 (Control 2)
- C-5**



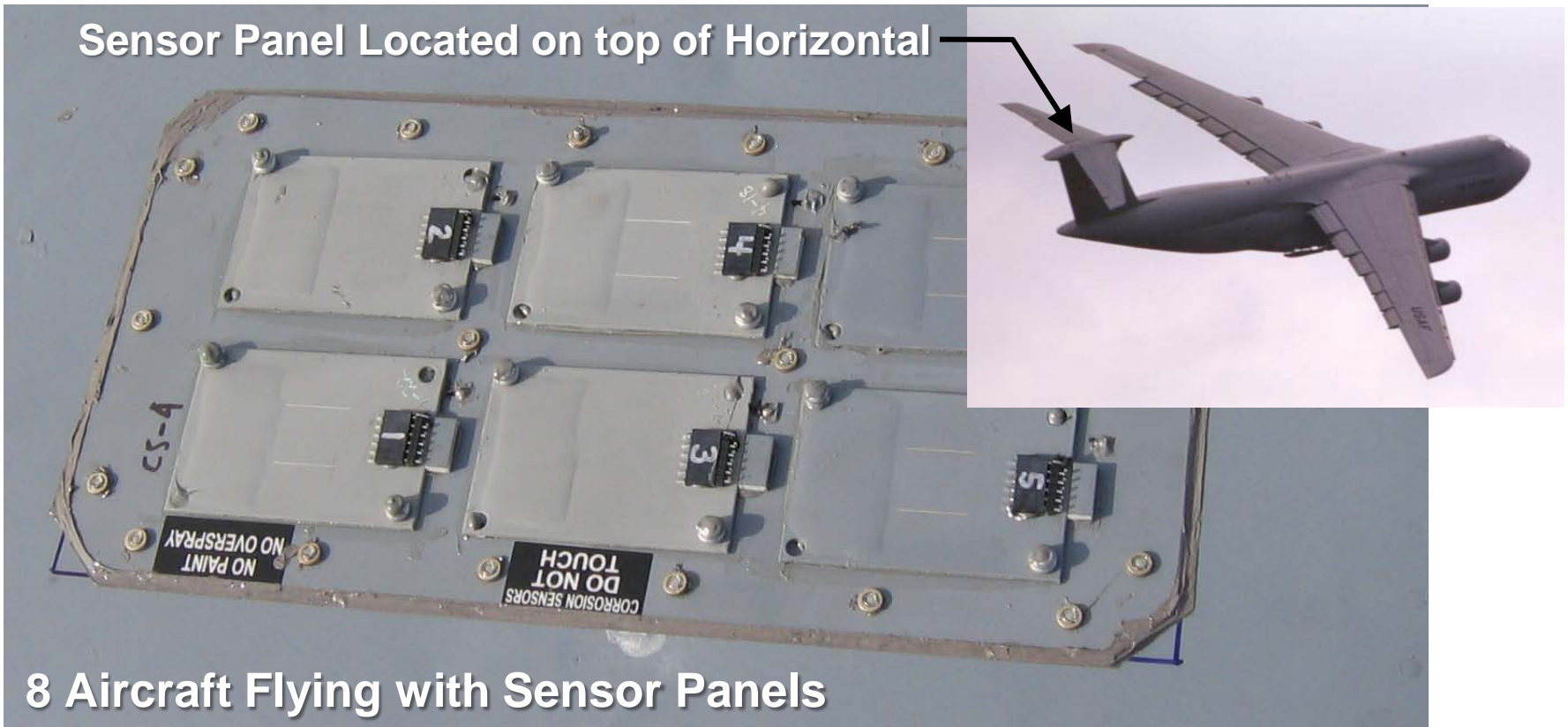
# Non-Chrome Finish Systems

## Flight Testing with Battelle Sensors



- Test coatings include all beachfront /lab test coatings.
- Following coating systems also in flight tests.
  - Turcoat Alumigold/Deft 44GN098(F-35)/Deft 99GY001
  - Alodine 5700/Deft 02GN084(F-22)/Deft 99GY001

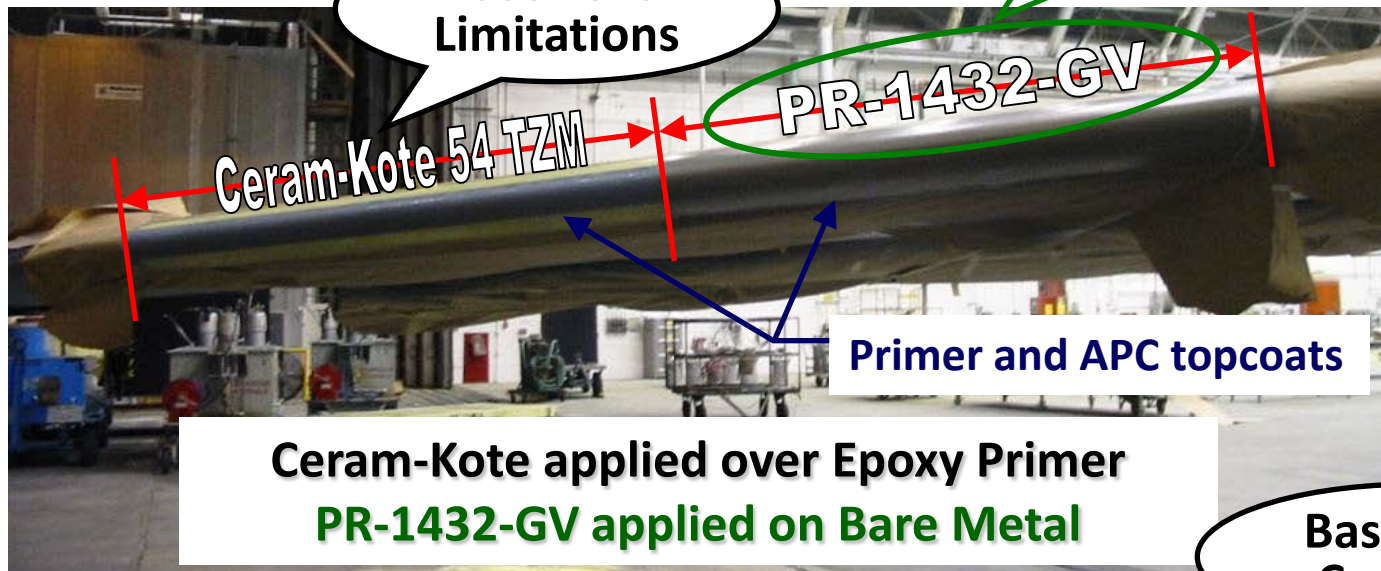
Sensor Panel Located on top of Horizontal



8 Aircraft Flying with Sensor Panels



# Leading Edge Coatings Evaluations Completed



150 Day  
Interval  
Evaluations  
Completed  
over 420 Day  
Period

- Wing
- Horizontal
- Vertical
- Nose Plug





## *Slat Lower Surface Coating and Wing Leading Edge Tape to Reduce Wear*

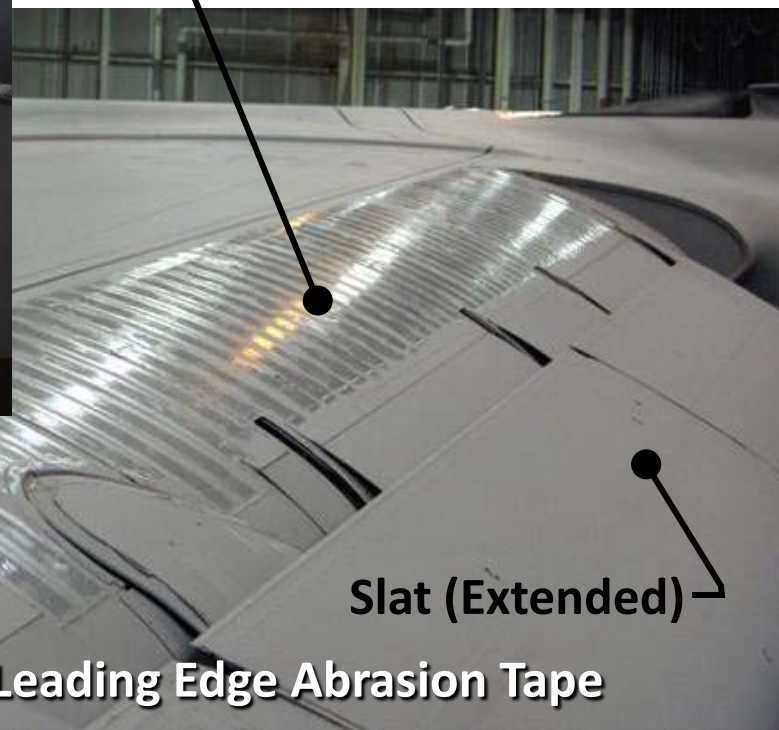


**Desothane® HS CA8100  
Anti-Chafe Topcoat  
under Slat**

**8681 HS Tape with  
DP190 Edge Seal on  
top of wing**

**Slat (Extended)**

**Slat Lower Surface Anti-Chafe Coating**



**Slat (Extended)**

**C-5 Wing Leading Edge Abrasion Tape**

**8681HS (Color 36173) Tape  
NSN 9330-01-580-6367  
DP190 Edge Seal  
NSN 1680-01-431-3607**



# ***Plastic Media Blasting (PMB)***

***Summit held at Robins on 8-9 June 2011***



- **Hydrogen peroxide activated benzyl alcohol (HP/BA) chemicals are still being used at Robins/Hill/Tinker AFB**
  - **Chemicals being used to de-paint non-composites**
  - **Scuff sanding on composites**
  - **More time would be required for PMB**
- **PMB (MIL-P-85891, Type VIII media) used on B-1 at Tinker AFB**
  - **Type VIII is used to acquire faster strip rate over Type VII**
  - **Media flow rates, nozzle pressure, stand-off distances, and impingement angles continue to be refined**
- **PMB (MIL-P-85891, Type VIII) used on CH-47 rotor blades.**
  - **US Technologies provided media recovery and separation system**
  - **Stripping performed by US Technologies certified artisans**
- **Type VIII media or any other media, if used incorrectly, can be devastating and detrimental to aircraft components**



# ***Plastic Media Blasting (PMB)*** ***on C-5***



- PMB (Type V media) on C-5 at Kelly AFB in 1990's
  - Approval based upon testing by SwRI
    - **PMB not possible on resin-starved composites**
    - **Facility has been converted back to chemical stripping**
- PMB (Type VIII media) being proposed for C-5 at Robins AFB
  - Need additional de-paint capability
  - Building 59D built for PMB stripping of C-5/C-17 aircraft
  - **PMB (Type VIII) not currently allowed on anodized/clad, composites, aluminum substrates less than 0.032 inches, and face sheets of bonded panels less than 0.016 inches**
    - Test plan submitted for evaluation of Type VIII media on surfaces outside existing limitations.
      - **Residual stress, fatigue life, anodize and cadmium removal, clad erosion, crack closure, surface roughness.**
  - Standard Process needs developed with aircraft mapping.
  - Training/Certification plan needs to be established.



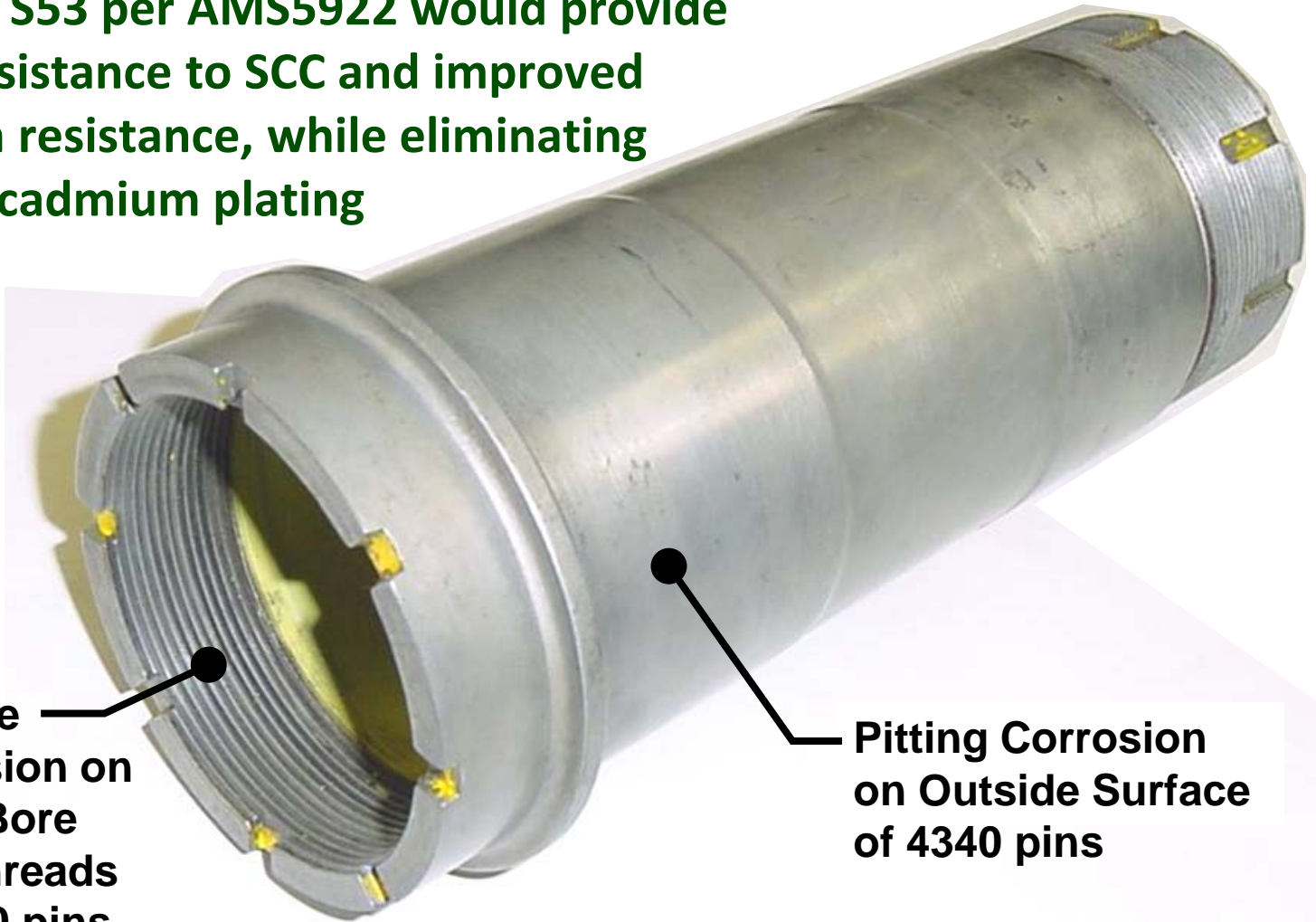
# **Horizontal Stabilizer Pivot Shaft Pin** **4340 replaced with Ferrium® S53**



**Ferrium® S53 per AMS5922 would provide higher resistance to SCC and improved corrosion resistance, while eliminating need for cadmium plating**

**Surface Corrosion on Inner Bore and Threads of 4340 pins**

**Pitting Corrosion on Outside Surface of 4340 pins**



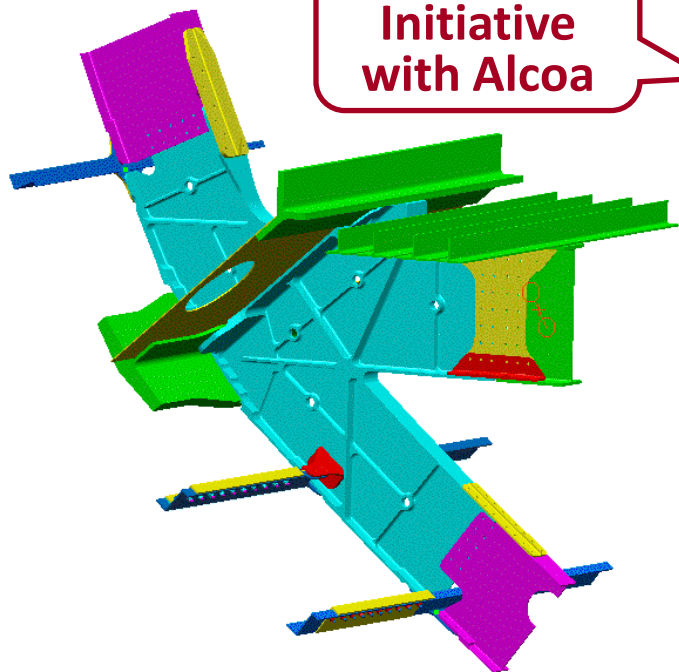


# ***Cargo Floor End Fitting Replacement***

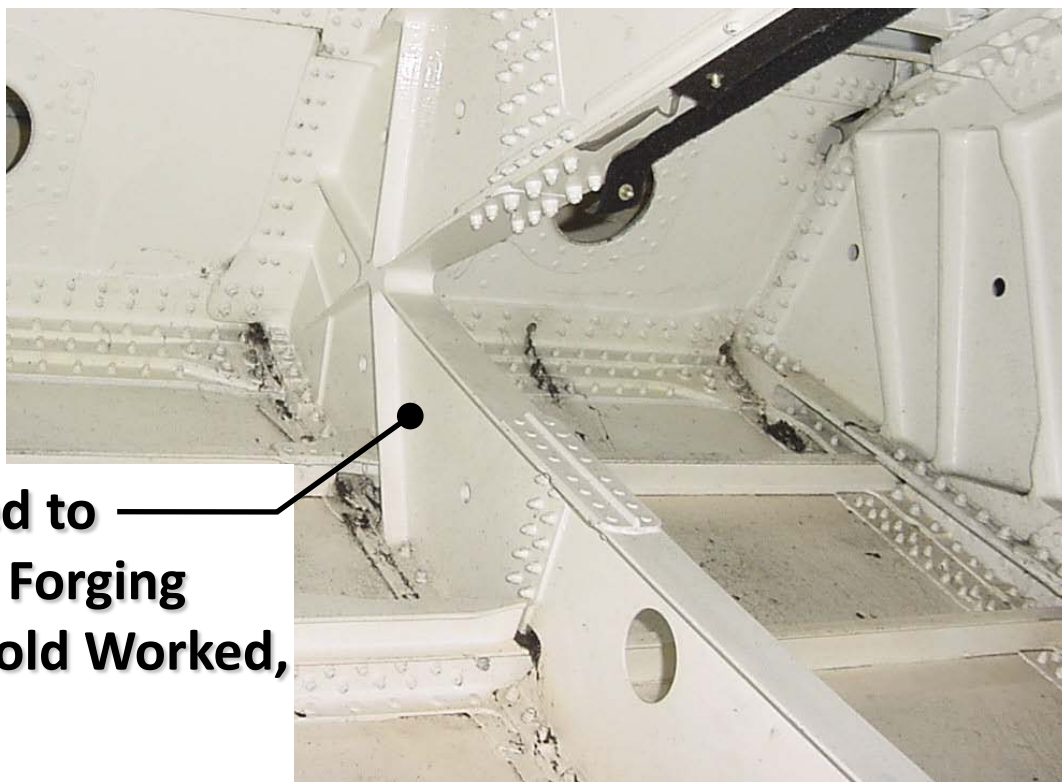
## ***Alloys selected with higher resistance to Stress Corrosion Cracking (SCC)***



**Current  
Initiative  
with Alcoa**



**7085-T7452 Die Forging per AMS4403 and 7085-T7452 hand forging per AMS4414 being Tested for Residual Stress, Crack Growth, and DTA based upon F-35 data.**



**7249-T73 Die Forging Selected to Replace Existing 7075-T6 Die Forging 7249-T7452 or 7050-T7452 Cold Worked, Hand Forgings as Alternate**



# ***C-5A Aft Crown Skin Replacement***

## ***FS1603 to FS2273***



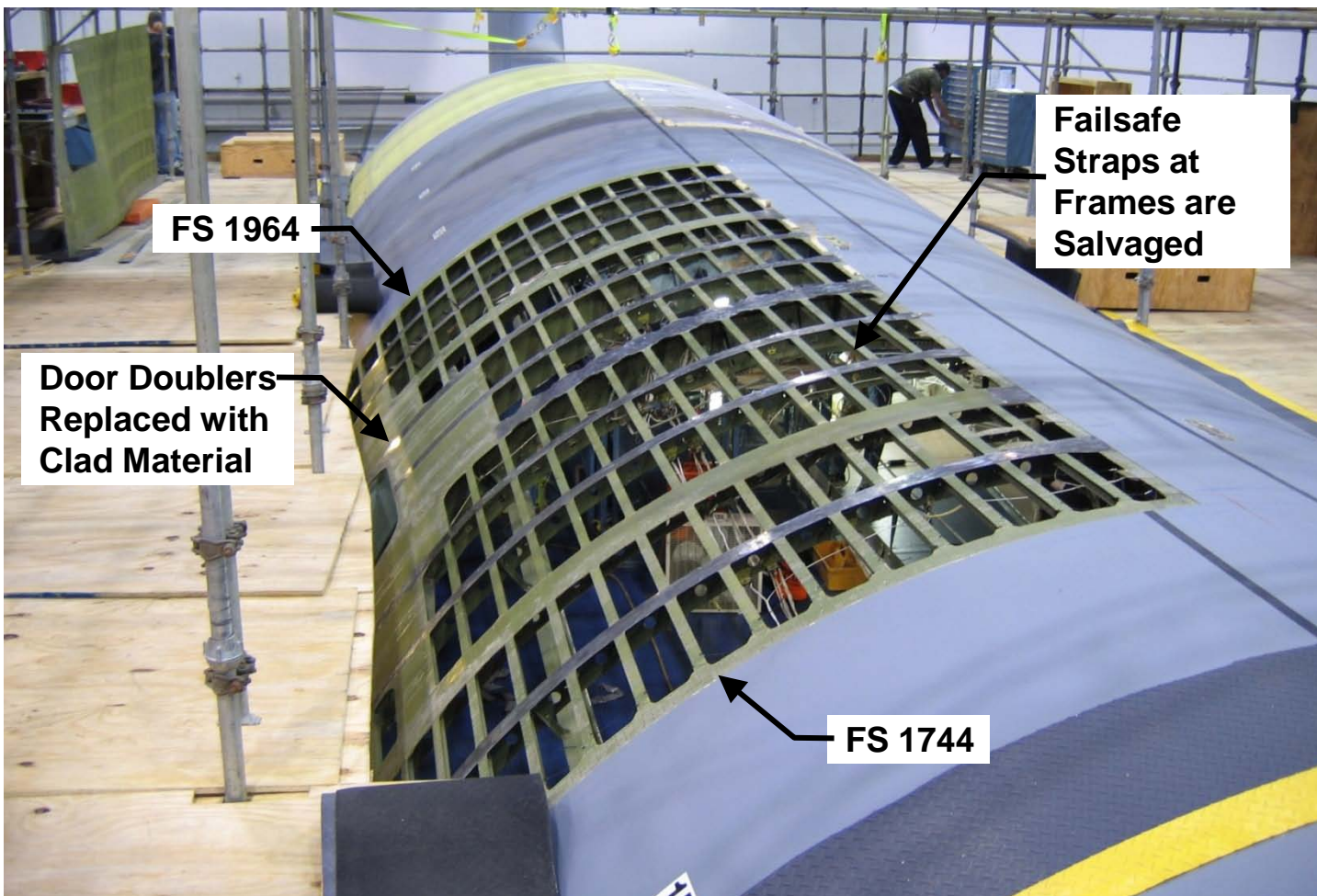
**Aft Crown Skins on C-5A were  
7079-T6 (one side Clad)**





# C-5A Aft Crown Skin Replacement

## 7475-T761 replaced 7079-T6



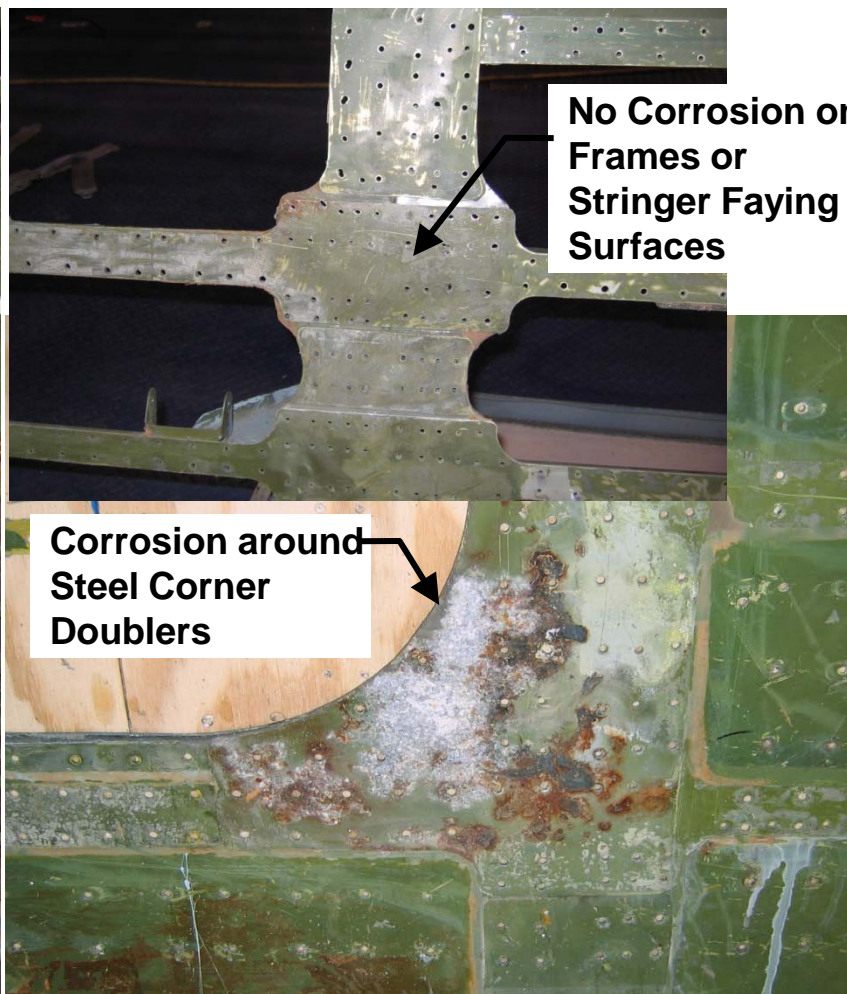
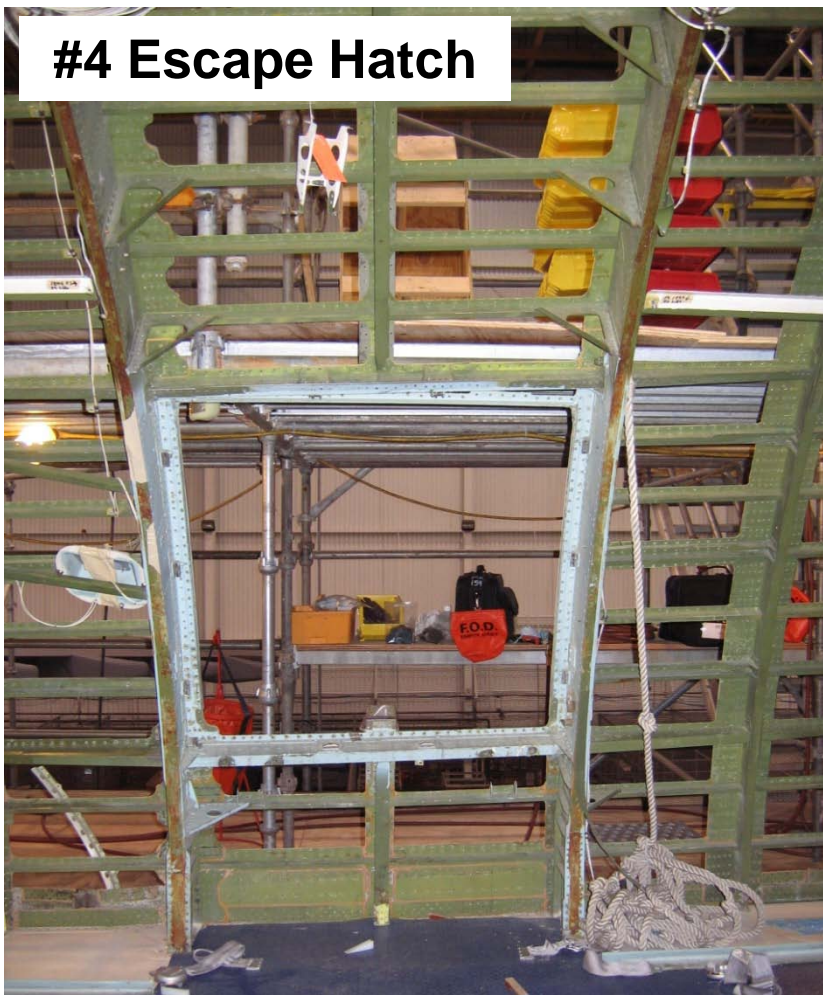


# C-5A Aft Crown Skin Replacement

## Access Doors had Steel Corner Doublers



**#4 Escape Hatch**





# *C-5A Aft Crown Skin Replacement*



- **Corrosion Issues:**
  - SCC cracks occurring in **7079-T6 skins**
  - **Corrosion around Doors and Hatches** (Galvanic )
  - **Corrosion found under Antenna** (Av-Dec Gaskets not used)
- **Inspections:**
  - No corrosion found on faying surfaces after removal of chromated sealant (MIL-PRF-81733).
  - **Faying surfaces of frames and stringers looked like new.**
  - Fastener holes were fine with adequate edge distance and clean up possible using next oversize fastener.
  - **No unexpected issues.**



# **C-5A Aft Crown Skin Replacement**

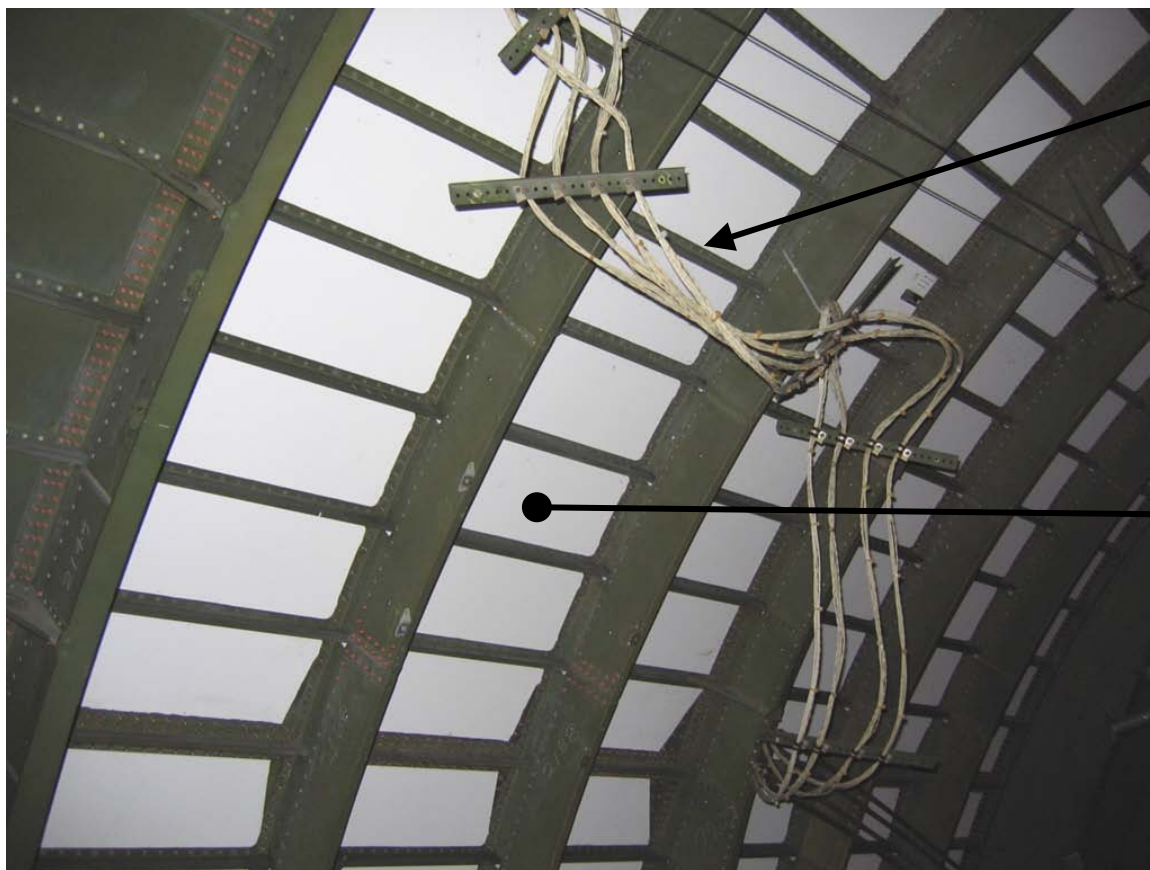
## **Corrosion Prevention Steps**



- **Skins**
  - 7079-T6 (1 side Clad) replaced with thicker **7475-T761 (2 side Clad)**
  - **Clad was sulfuric acid anodized**
  - **Chromated primer** applied to both internal and external surfaces (MIL-PRF-23377, Type I, Class C2)
  - Internal primed surfaces overcoated with **white polyurethane** (MIL-PRF-85285, Type I, Class H)
  - External primed surfaces overcoated with **99GY001 Deft APC** (MIL-PRF-85285, Type IV)
- **Doublers**
  - Steel (4130) corner doublers replaced with same thickness **7475-T761 clad aluminum** to eliminate galvanic corrosion
  - **Clad external Doublers** installed around all Doors/Hatches
- **Antenna**
  - **Av-Dec gaskets** installed under antenna



# ***C-5A Aft Crown Skin Replacement***



**MIL-PRF-81733  
Chromated Primer on  
all Faying Surfaces  
and Fasteners**

**Interior Skin Surfaces  
have 1 Coat of White  
Polyurethane over  
Chromated Primer**



# Aircraft Wash Procedures

## T.O. 1C-5A-23-1



- Aircraft Configuration
- Covers, Tooling, Equipment List
- Masking List with Pictures
- Masking Tape (3M 8979N)
- Masking Foil (MIL-PRF-131)
- Soap Type and Dilution
- Nozzles (40 °)
- Wash Pads
- Sequencing
- Inspection
- Aircraft Restoration



# Aircraft Wash Pads

## 6" x 12" Used on C-5 Aircraft



**3M #261 Conformable Application Heads**  
**NSN 6850-01-499-5307**



**Melamine Pads**  
**NSN 7920-01-526-9003**

**Cleaning efficiency for Melamine is superior to white Scotch-Brite™ on soot.**

**Melamine Pads tend to Wear Out Fast if Force Used Similar to Scotchbrite Pads**

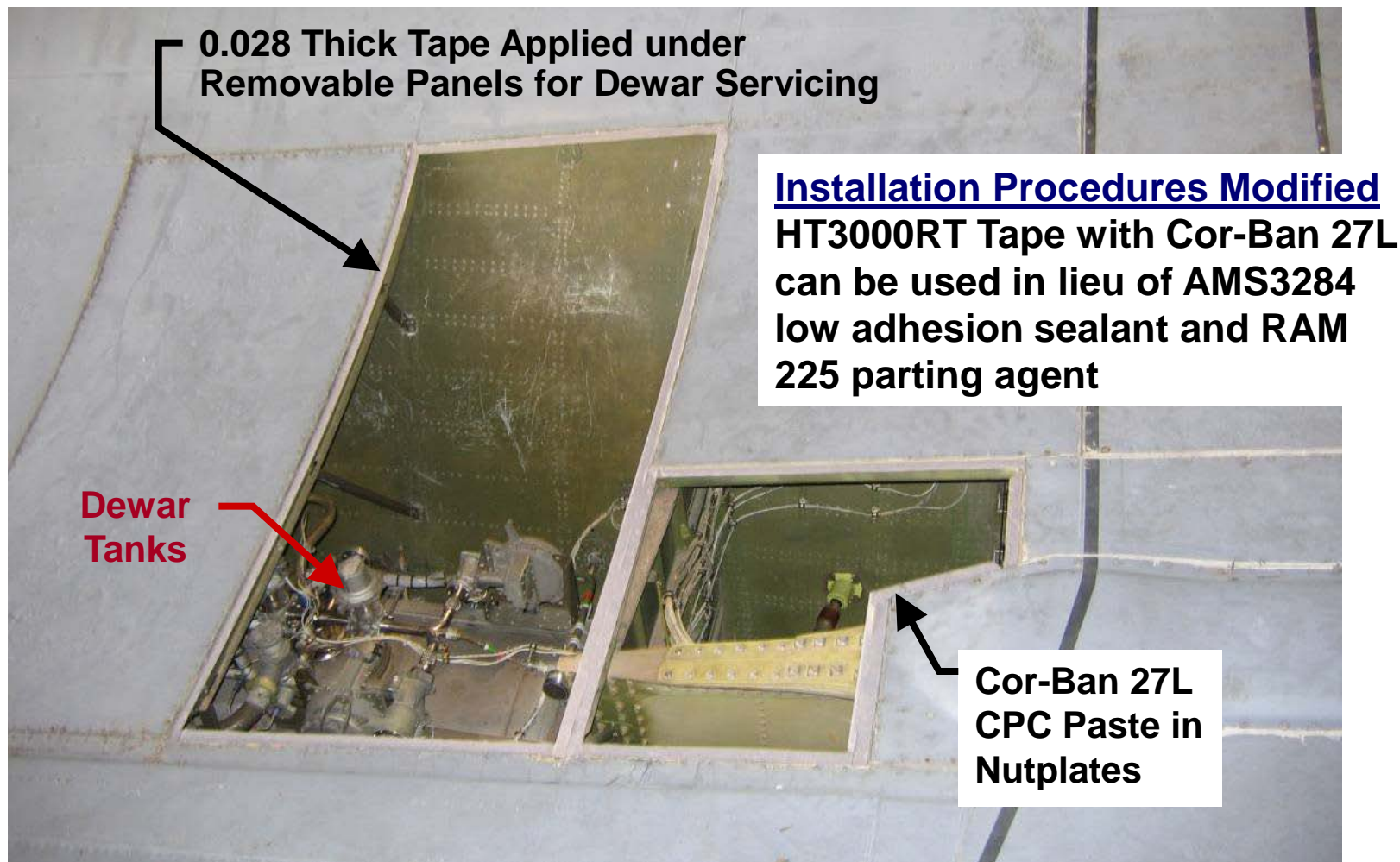


**Scotch-Brite™ Pads with Rubber Coating**  
**NSN 6850-01-496-4901**



# Removable Panel Installation

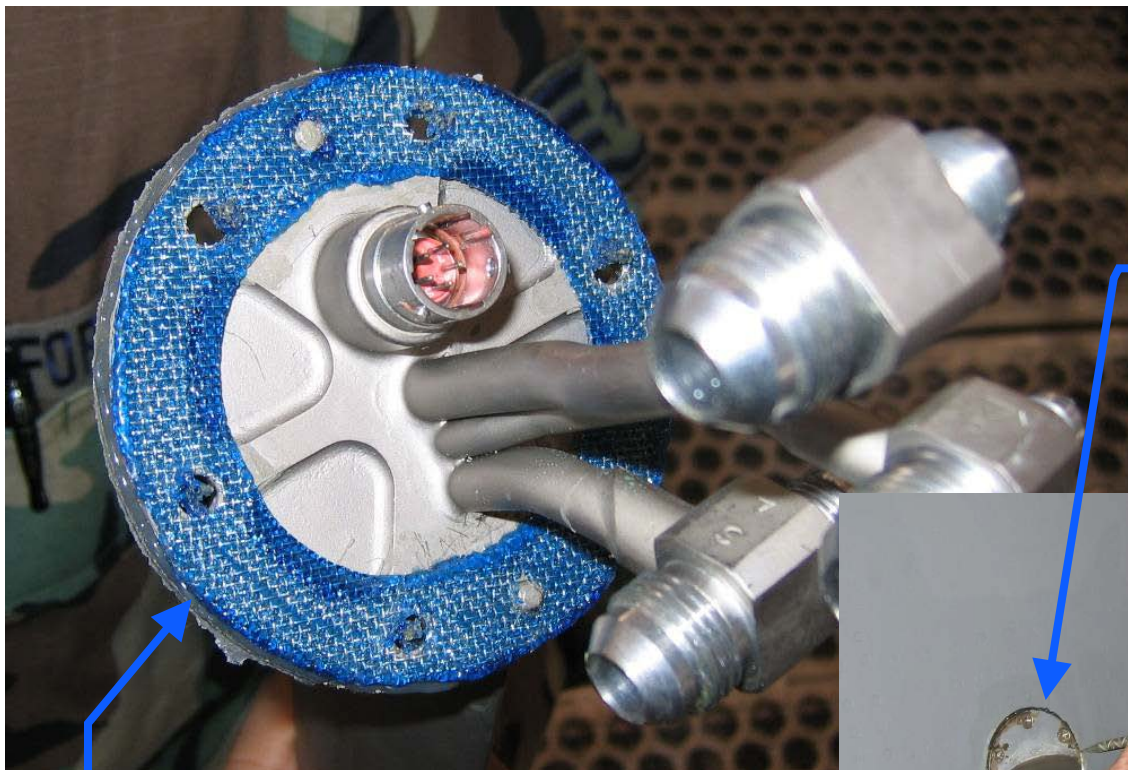
## Av-Dec® HT3000RT Tape



Modified T.O. 1C-5A-23, Para 4-4.11, and T.O. 1C-5A-3, Table 12-7



# ***Pitot Tube/Antenna Installation*** ***Av-Dec® Gasket and Thixoflex™ Gray***



**AG778000-11  
Polyurethane  
Conductive Gasket**

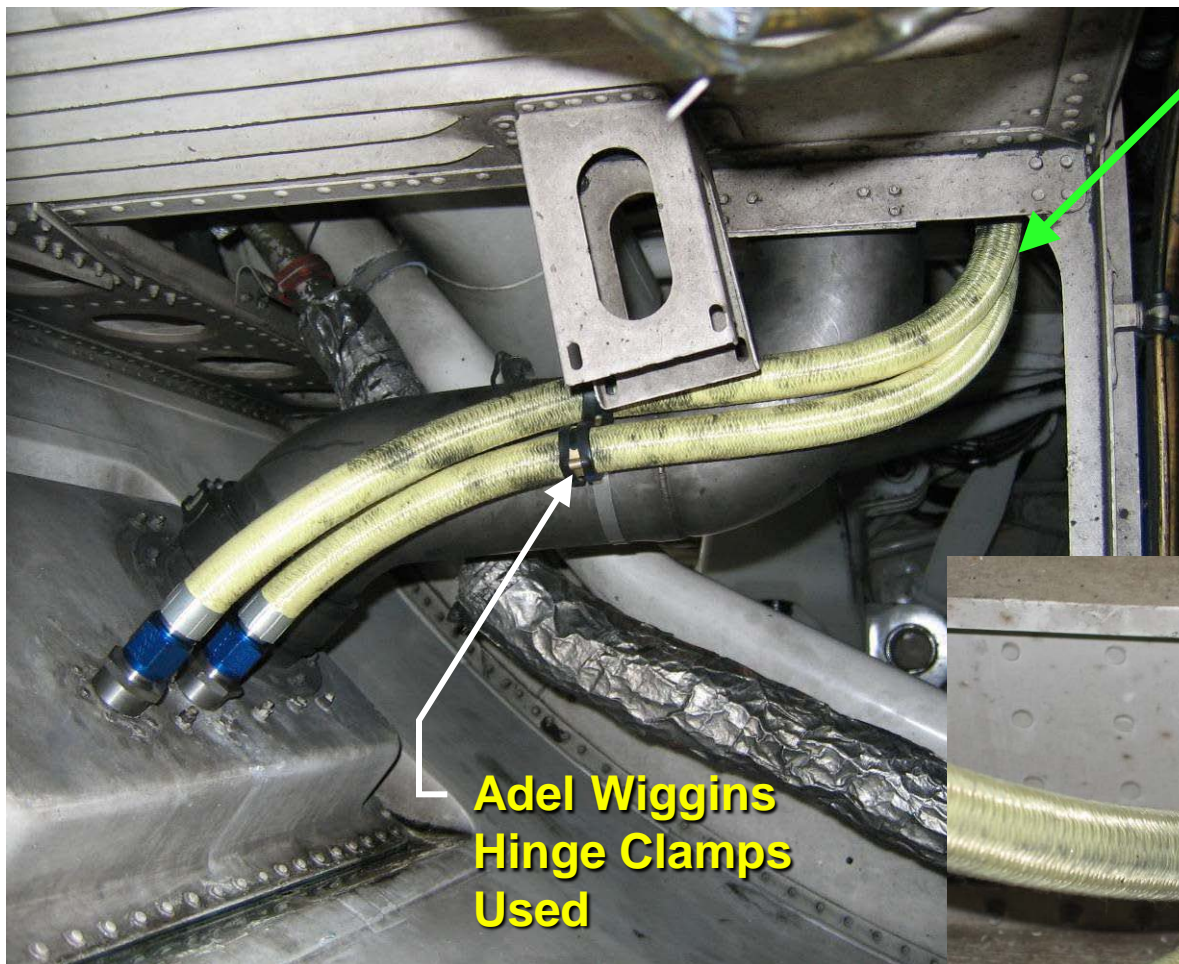
**TG8498-50  
Thixoflex™  
Gray to fill Gap**





# **New Lavatory Fluid Supply Hoses**

## **TCTO 1C-5-813**



**Adel Wiggins  
Hinge Clamps  
Used**

**Adel Wiggins  
HHB101  
Commercial Hoses  
(FAA approved)**

**Flared Plumbing  
Fittings Swaged  
onto Hoses**



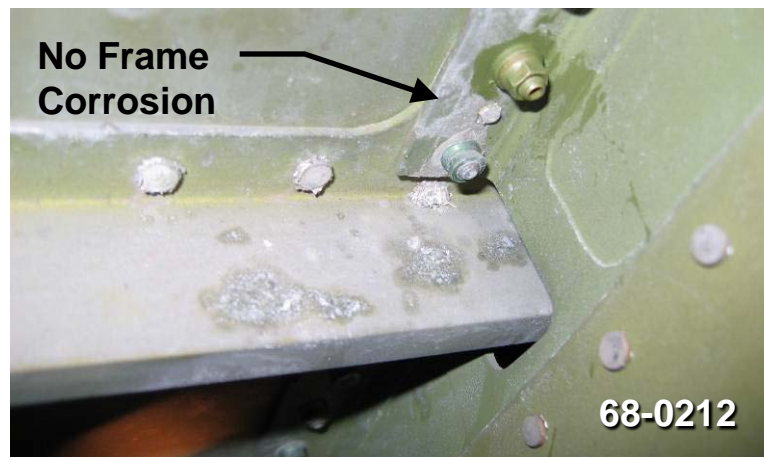
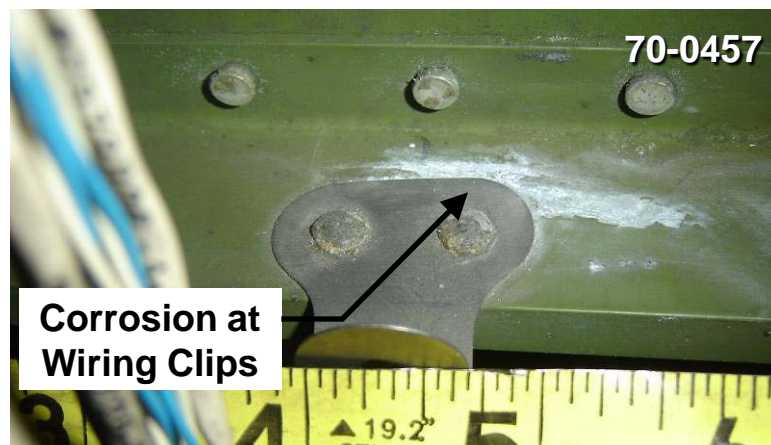
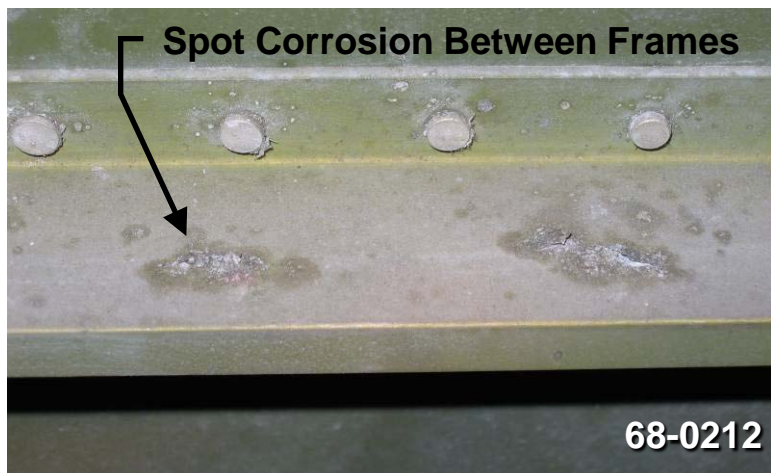


# **Stringer Corrosion**

## ***Grind Outs and Repairs Developed***



**Corrosion Grind Outs Preferred over Section Removals**



**Cor-Ban® 35 now being applied at Depot for Corrosion Prevention**



# Fuel Tank Access Flange Corrosion

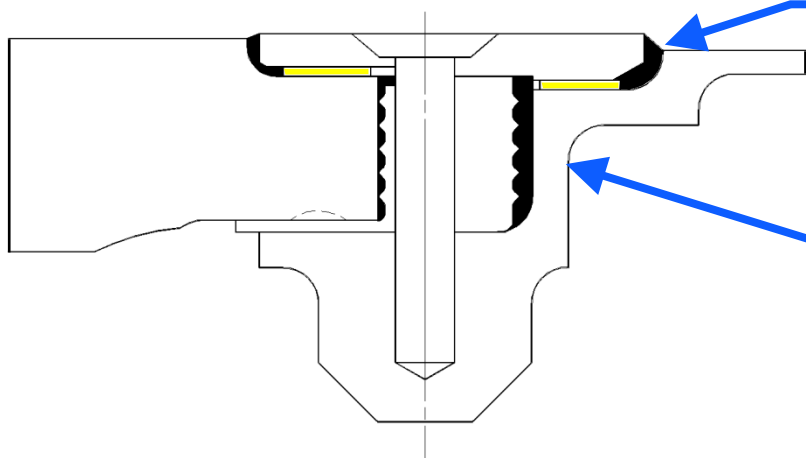
## Grind Out Limits Established



**Complete Squeeze-Out of Sealant Required around Door Retaining Ring to Prevent Moisture Entry**

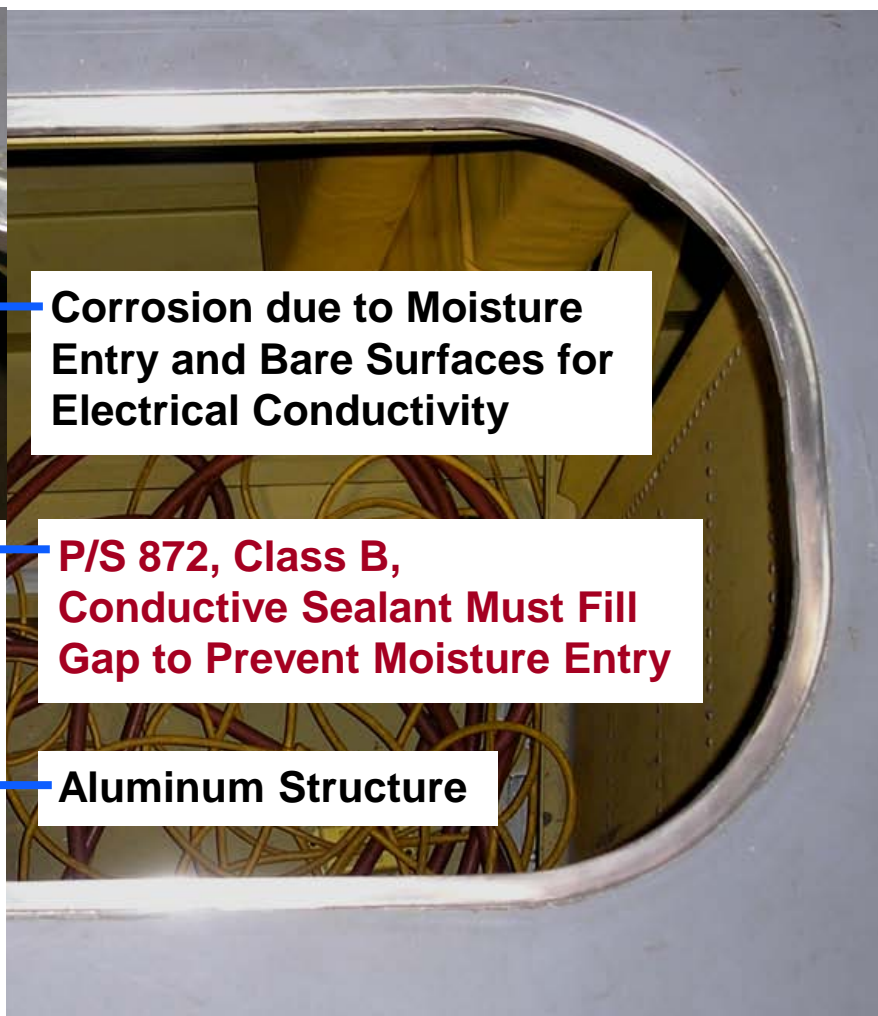


**Corrosion due to Moisture Entry and Bare Surfaces for Electrical Conductivity**



**P/S 872, Class B,  
Conductive Sealant Must Fill  
Gap to Prevent Moisture Entry**

**Aluminum Structure**





# Structural Bonding Process Improvements

## *Grit-Blast Sol-Gel with Fused Primer*



Grit-Blast/Sol-Gel Surface Preparation  
prior to Bonding required on Primary  
and Critical Secondary Structure at  
Base and Depot Level per TO 1C-5A-3

Scotch-Brite/Sol-Gel Surface  
Preparation only permitted at Field  
Level on Secondary Structure

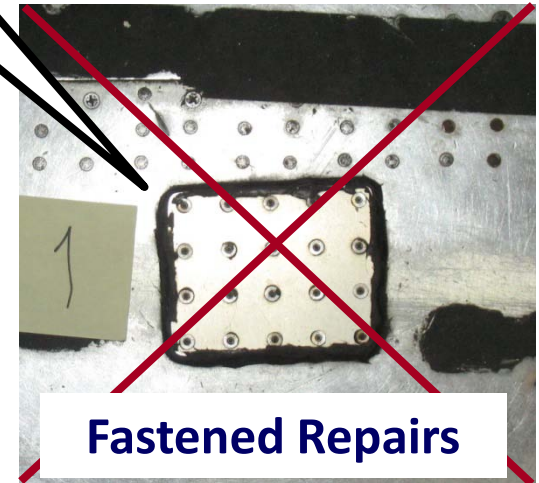


Grit-Blast Process

Internal  
Corrosion  
Issues



Bonded Repairs



Fastened Repairs



# Bonding Certification Procedure for Primary and Critical Secondary Structure

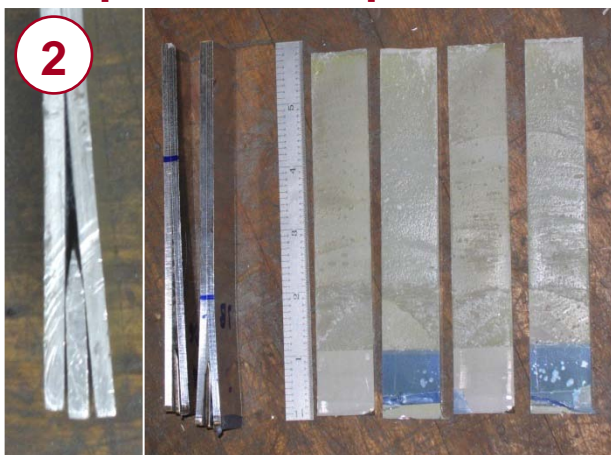
## Specimen Fabrication



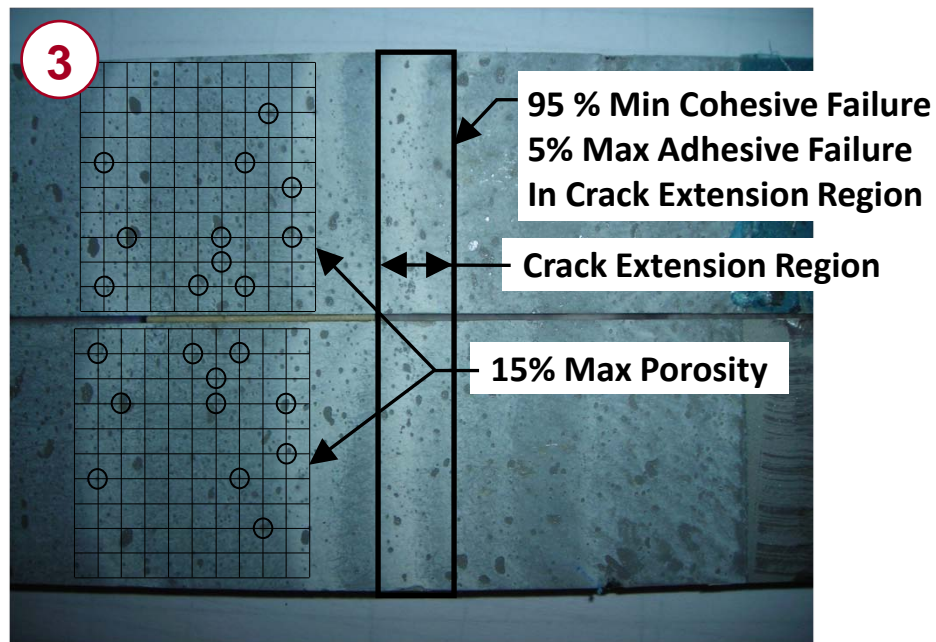
Procedure developed from ASTM D3762 to allow certification of personnel at base and depot level

**Humidity Chamber Required**

**Wedge Insertion  
Environmental Exposure  
Crack Extension Measurement  
Specimen Separation**



## Failure Mode Evaluation





# ***CPC Applications added to Maintenance Work Cards***



## **MSG-3 Guidelines**

**After initial applications, only touch-ups  
will be required at subsequent checks.**

**CPC applications will be a fluid program  
and will be adjusted as needed.**

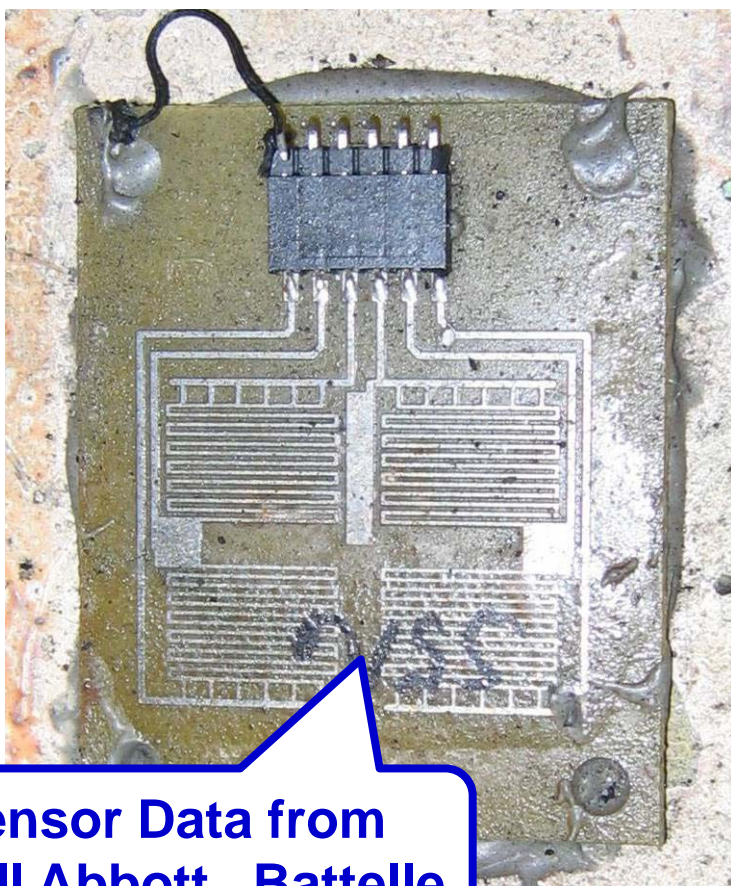


# ***CPC Usage Based upon Battelle Sensor Data and Visual Inspections***

***Bare and CPC Coated Copper and Steel Sensors Used***

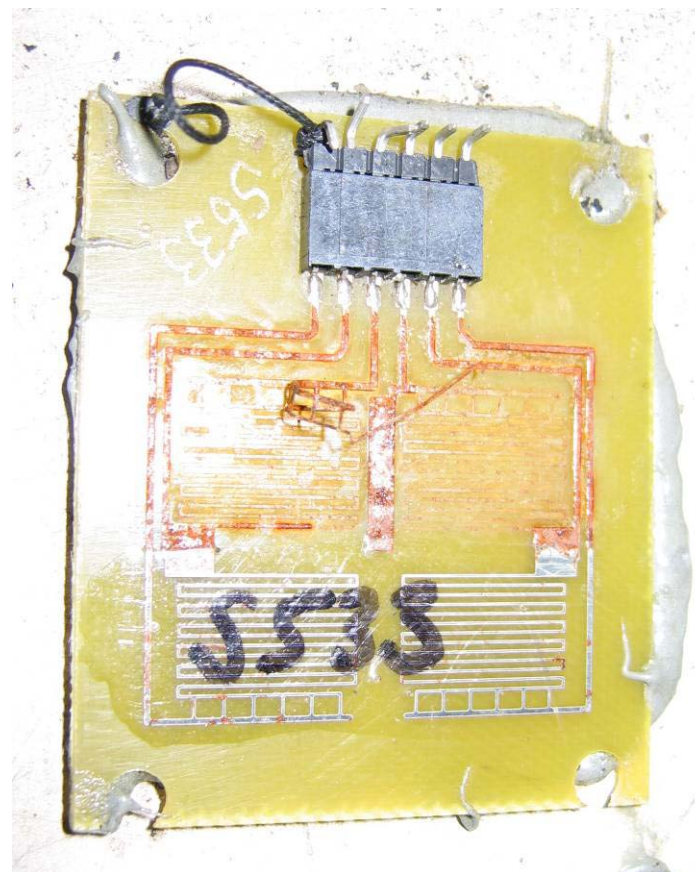


**Coated Steel Sensor  
(No Corrosion)**



**Sensor Data from  
Bill Abbott , Battelle**

**Bare Steel Sensor  
(Expired)**



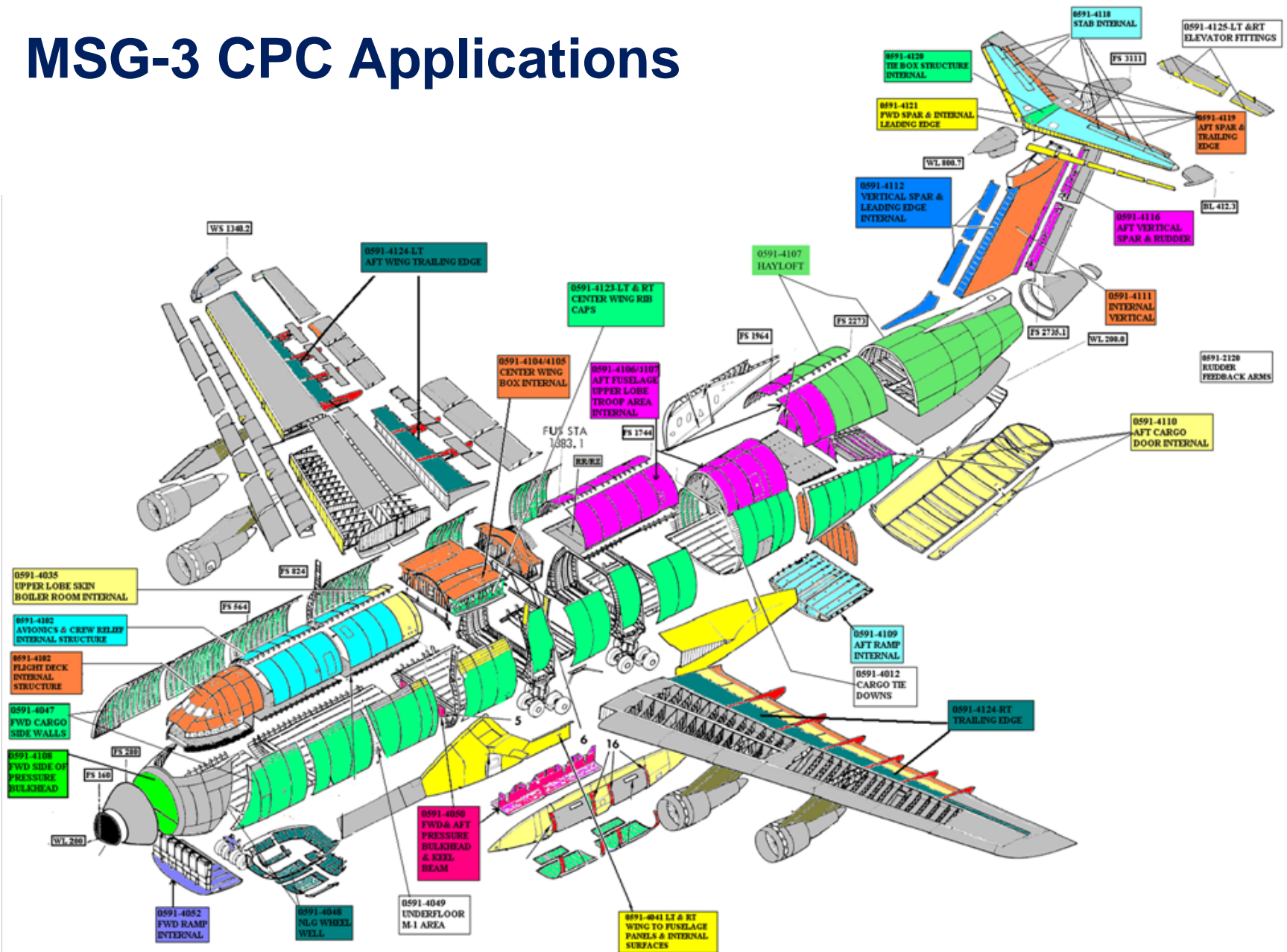


## ***CPC Products Selected***



- **Hard Film (*Cor-Ban 35 Undyed*)**
  - Used on surfaces with no corrosion after visual inspection.
  - Penetrating, water-displacement capabilities along with barrier type performance with one product.
  - Cure to a very firm, non-tacky, barrier type film.
- **Wax Film (*Cor-Ban 22*)**
  - Used on surfaces which have, or may have, corrosion and are not likely to be in contact with corrosive fluids or particles.
  - Excellent exposed surface protection on high strength steel.
  - Does not penetrate faying surfaces very well.
  - Dirt accumulation a problem with tacky coating.
- **Oil Film (*LPS2 for Non-Avionics, Super Corr-A for Avionics*)**
  - Used on surfaces which may have corrosion and are susceptible to corrosive fluids or materials. **(Bilge)**
  - Penetrate voids, cracks, and faying surfaces to displace fluids.
  - Less effective in areas of high water runoff when compared to waxy or hard film compounds.
- **Paste Film (*Cor-Ban 27L*)**
  - Anti-seize compound for removable fasteners.

# MSG-3 CPC Applications





# Anti-Seize Paste Film CPC

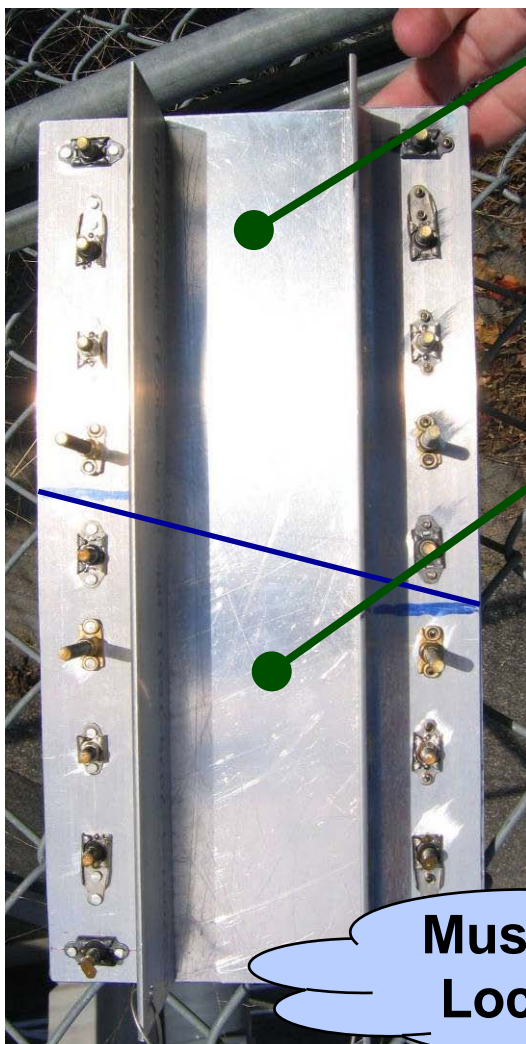
## Cor-Ban 27L on Removable Fasteners



Evaluation



Incorporation

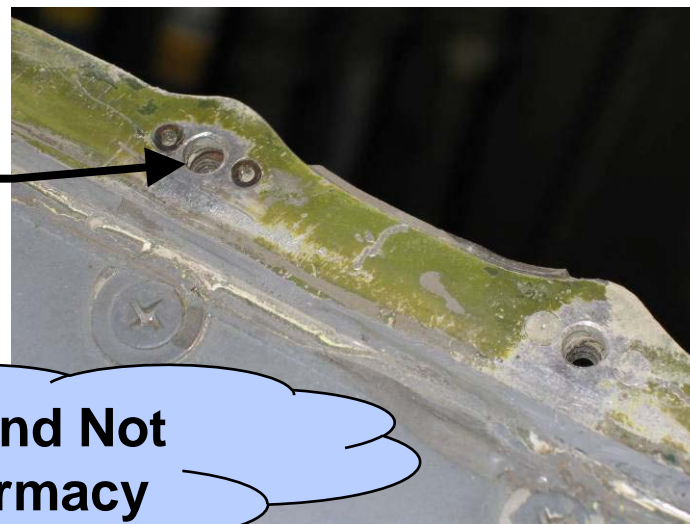
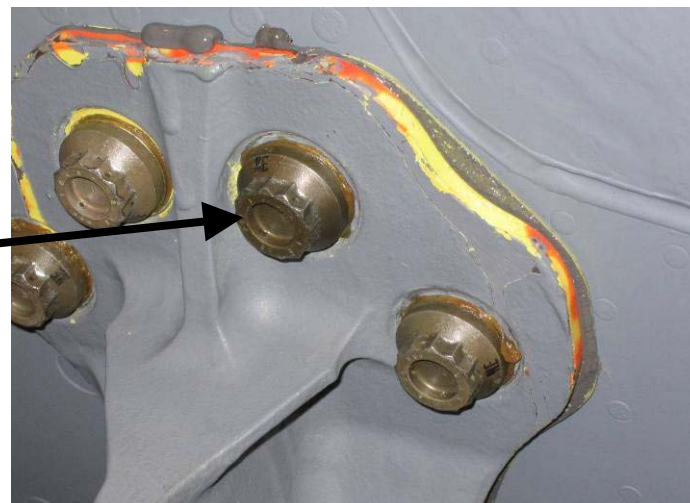


Fasteners  
Installed Bare  
(No CPC)

Jackpad  
Bolts at  
FS524 and  
FS1964

Fasteners  
Installed with  
Cor-Ban 27L

Removable  
Panel  
Fasteners



**Must be Accessible and Not  
Locked Away in Pharmacy**



# C-5M Interior Refurbishment at Stewart ANGB

**Lighting, Trim Panels (Gray), Anti-Skid**





# CESCO Aqua Miser™ Ultra Boss D-115

## Anti-Skid Removal Evaluation

**Anodize Surface cannot be Damaged**



**Anodize Thickness Verified  
(0.3 to 0.5 mil)**



**Edges  
Manually  
Removed**

